2.0 Physical Description

2.1 Proposed Line

The proposed 500-kV transmission line would be a three-phase, single-circuit line placed on either single-circuit or double-circuit structures. The single-circuit towers would have the three phases arranged in a delta (triangular) configuration: the double-structure towers would have two sets of three phases arranged vertically on either side of the structure. Voltage and current waves are displaced by 120° in time (one-third of a cycle) on each electrical phase. The maximum phase-to-phase voltage would be 550 kV; the average voltage would be 540 kV. The maximum electrical current on the line would be 1800 A per phase, based on the BPA projected normal system annual peak load with 2005 as the base year. The load factor for this load would be about 0.50 (average load = peak load x load factor). BPA provided the physical and operating characteristics of the proposed and existing lines.

The electrical characteristics and physical dimensions for the configurations of the proposed and existing lines in the corridor are shown in Figure 1, and summarized in Table 2. For most of the proposed route, each phase of the proposed 500-kV line would have three 1.3-inch (in.) (3.30-centimeter [cm]) diameter conductors (ACSR: steel-reinforced aluminum conductor) arranged in an inverted triangle bundle configuration, with 17-in. (43.3-cm) spacing between conductors. In some sections with double-circuit structures, the conductors would be 1.602 inches (4.07 cm) in diameter and 19.75 inches (50.2 cm) apart.

For the single-circuit configurations the horizontal phase spacing between the lower conductor positions would be 48 ft. (14.6 m). The vertical spacing between the conductor positions would be 34.5 ft. (10.5 m). For the double-circuit configurations, the horizontal spacing between conductor positions would be 36.5 ft. (11.1 m), 56.5 ft. (17.2m), and 36.5 ft. (11.1 m); the vertical spacing would be 36 ft. (11.0 m). The spacing between conductor locations would vary slightly where special towers are used, such as at angle points along the line.

Minimum conductor-to-ground clearance would be 35 ft. (10.7 m) at a conductor temperature of 122°F (50°C); clearances above ground would be greater under normal operating temperatures. The average clearance above ground along a span would be approximately 45 ft. (13.7 m); this value was used for corona calculations. At road crossings, the ground clearance would be at least 54 ft. (16.5 m). The 35-ft. (10.7-m) minimum clearance provided by BPA is greater than the minimum distance of the conductors above ground required to meet the National Electrical Safety Code (NESC) (IEEE, 2002). The final design of the proposed line could entail larger clearances. The right-of-way width for the proposed line would vary, depending on location and the presence of parallel lines. For most of the proposed corridor, the line would be placed between existing lines and would not abut the edge of the existing right-of-way.

The electrical phasing of the proposed line was selected to ensure that BPA criteria for electric-field and audible-noise levels would be met. During the design process, BPA will verify that any changes from the phasing described here continue to meet design criteria.

2.2 Existing Lines

Ten possible corridor configurations were identified for analyzing electrical effects along the route from Grand Coulee Substation to Bell Substation (Table 1). These configurations are:

1. the proposed line parallel to and east of the existing Grand Coulee – Hanford 500-kV line;
2 the proposed line with no parallel lines;

3. the proposed line on single-circuit structures parallel to four existing BPA lines in the Grand Coulee – Bell corridor;
4. the proposed line on a double-circuit structure with an existing 115-kV line and parallel to two existing BPA lines;
5. the proposed line on double-circuit structures parallel to four existing BPA lines;
6. the proposed line on single-circuit structures parallel to four existing BPA lines and two Avista lines (north);
7. the proposed line on double-circuit structures parallel to four existing BPA lines and two Avista lines (north);
8. the proposed line on single-circuit structures parallel to four existing BPA lines and two Avista lines (south);
9. the proposed line on double-circuit structures parallel to four existing BPA lines and two Avista lines (south); and
10. the proposed line on double-circuit structures parallel to one existing BPA lines and two Avista lines (south).

The physical and electrical characteristics of the corridor configurations that were analyzed are given in Table 2; cross-sections of the corridors are shown in Figure 1. Short sections of the proposed line where transitions between configurations would occur and where the line would enter the substations were not analyzed.

Changes in the electrical phasing of the existing lower-voltage lines occur along the proposed corridor. The phasing scheme in place for the first 12 mi. (19.3 km) west of the Bell Substation was used for calculations. Further west along the corridor the different phasing schemes would produce very similar electric and magnetic fields and corona effects.

3.0 Electric Field

3.1 Basic Concepts

An electric field is said to exist in a region of space if an electrical charge, at rest in that space, experiences a force of electrical origin (i.e., electric fields cause free charges to move). Electric field is a vector quantity: that is, it has both magnitude and direction. The direction corresponds to the direction that a positive charge would move in the field. Sources of electric fields are unbalanced electrical charges (positive or negative) and time-varying magnetic fields. Transmission lines, distribution lines, house wiring, and appliances generate electric fields in their vicinity because of unbalanced electrical charge on energized conductors. The unbalanced charge is associated with the voltage on the energized system. On the power system in North America, the voltage and charge on the energized conductors are cyclic (plus to minus to plus) at a rate of 60 times per second. This changing voltage results in electric fields near sources that are also time-varying at a frequency of 60 hertz (Hz; a frequency unit equivalent to cycles per second).

As noted earlier, electric fields are expressed in units of volts per meter (V/m) or kilovolts (thousands of volts) per meter (kV/m). Electric- and magnetic-field magnitudes in this report are expressed in root-mean-square (rms) units. For sinusoidal waves, the rms amplitude is given as the peak amplitude divided by the square root of two.